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published in
Transportation Human Factors
2000

DOI (link to publisher)
10.1207/sthf0201_2

document version
Publisher's PDF, also known as Version of record

TRANSPORTATION HUMAN FACTORS, 2(1), 19–22

COMMENTARIES

Commentary on Räsänen and Summala, "Car Drivers' Adjustments to Cyclists at Roundabouts"

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The important message of Räsänen and Summala's (2000) study is the notion that during driving, visual search for driving-relevant objects is mainly guided by top-down factors. The study elegantly demonstrates that drivers entering roundabouts tend to direct their attention (defined as the direction of head movements) mainly to the left of the visual field. This direction of attention does not depend on whether other traffic is coming from the left; the notion is that drivers check the left side of the visual field because they have "knowledge" that on roundabouts other traffic (including cyclists) typically comes from the left. This in itself is an adequate strategy, because the drivers' knowledge is used to optimize the visual scan path. The strong point of Räsänen and Summala's study, however, is that it shows that there is a price to pay for this top-down guided search: In many instances a cyclist approaching from the right did not prompt a head movement, suggesting that drivers failed to detect him. Even though, as recognized by Räsänen and Summala, the absence of a head movement in the direction of the cyclist may not necessarily indicate a failure to detect the cyclist, additional evidence indicating that drivers who did not look to the right also showed an increased tendency to not yield to the cyclist also hints toward an explanation that such drivers failed to detect the cyclist from the right. Note that the study was conducted during daytime in the summer under conditions in which it is likely that the cyclist was clearly visible.

These findings suggest that driving-relevant objects, such as relevant road users who have the right of way, are on a collision course and are clearly visible (such as the cyclist in Räsänen & Summala's [2000] study) do not necessarily capture our attention if the relevant object is in a location (or area) within the visual field that does not fit our expectancies. This is an important claim, because it has often been assumed that an object that is relevant, salient, and visible enough will capture our attention independent of its location in relation to the line of fixation (see, e.g., Hughes & Cole, 1984; Theeuwes, 1991). When someone overlooks, for example, a sign, we typically suggest that the sign be made more conspicuous, that is, more salient so that in the future the sign will not be overlooked. Räsänen and Summala's (2000) study shows that top-down expectancies are more important in guiding search behavior than are aspects of conspicuity and saliency.

A crucial question is how these top-down expectancies develop and how these expectancies guide search behavior. Previous experiences that drivers have with particular situations (such as

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roundabouts) create prototypical representations for these situations. The prototypical representation of traffic environments contains information regarding the typical spatial relationships between the road elements and road users, called *schemas* (e.g., McClelland & Rumelhart, 1981), and information regarding the typical sequences of events in time, called *scripts* (Minsky, 1975). Recognizing a particular traffic situation (such as a roundabout) will activate particular scripts and schemas, which in turn influence where—in place and in time—particular road users and elements can be expected. Thus, in Räsänen and Summala's (2000) study, entering a roundabout will induce expectancies regarding where cyclists are likely to be, causing drivers to typically sample only the left side of the visual field. Obviously, if the environment induces inappropriate expectations (as in Räsänen & Summala's study), then errors in visual sampling are likely to occur.

In a series of laboratory studies, I (Theeuwes, 1996; Theeuwes & Hagenzieker, 1993) demonstrated that the wrong expectations regarding where in the visual field the relevant information is located will indeed result in a failure to detect these objects. In my studies, participants searched traffic scenes and had to determine whether a particular traffic sign or a particular road user (e.g., a cyclist) was present in the scene. Participants responded "yes" when they found the object and "no" if they thought that the object was not present. In these experiments the relevant object was either in a location that was in line with the particular scene layout (expected location) or at an unlikely location within the scene (unexpected location). For example, a cyclist who needed to be detected was located either on the bike path on the right side of the road (expected location) or on the left side on the main road (unexpected location). The results showed that on many occasions participants did not detect relevant objects when they were located at an unexpected location within the scene. In many instances participants responded "object not present" when in fact the object was located somewhere in the visual scene, yet at an unexpected location. My subsequent eye movement study (Theeuwes, 1996) confirmed these findings, showing that people direct their eye fixations only to locations that are likely to contain the target object.

These studies show that search behavior is biased toward portions of the visual field where the relevant source of information is expected. It should be realized that the effects of a top-down search will be particularly strong in cases in which there is a relatively high visual load (e.g., driving in busy traffic in urban environments) or under reduced sight conditions (e.g., driving in the dark or in twilight). As Räsänen and Summala (2000) also showed, in cases of high-speed driving drivers rely more on top-down guided search than when they drive slowly. As Räsänen and Summala noted, speed modifies visual search patterns, suggesting that with increasing speeds drivers tend to scan only the most relevant locations.

Accident data regarding errors that occurred in driving also stress the importance of expectations. For example, accident data show that a large portion of drivers (about 37%) involved in automobile crashes do not act too late, but do not act at all, to avoid the collision (Sussman, Bishop, Madnick, & Walter, 1985). The finding that most people did not act at all may suggest that they failed to detect the road user who was on a collision course with them. Failure to detect relevant other traffic may be related to inadequate expectations regarding the location at which other road users may appear. In fact, Malaterre (1986) claimed that 59% of all accidents are the result of inappropriate expectations or interpretations of the environment.

Another aspect that needs to be considered is that, for an individual driver, traffic accidents (luckily) seldom occur, indicating that errors in visual sampling, that is, failing to detect a relevant object (e.g., failing to detect a cyclist on a collision course) are not fed back to the driver. For example, as in Räsänen and Summala's (2000) study, to prevent an accident the cyclists approaching from the right simply stopped. Typically, in these circumstances the driver keeps on driving without ever knowing that he or she failed to detect the cyclist at the right. On the other hand, correct expectancies, that is, finding an object where you expected it (finding the cyclist to the left), are consistently reinforced when an object is found in the correct place.

Because expectations play such an important role, it is crucial that the design of roads be adjusted to these expectations. Purely by their design, roads should elicit safe behavior (Alexander & Lunenfeld, 1986; Theeuwes, 1998; Theeuwes & Godthelp, 1995). By taking into account the constraints and the limitations of the driver, road design can reduce the number of errors that occur in traffic. The type of road that elicits safe behavior simply by its design has been referred to as a self-explaining road (Theeuwes & Godthelp, 1993). Along similar lines, Alexander and Lunenfeld (1986) developed the concept of *positive guidance*, referring to road environments that are in line with the expectations of the road users.

On theoretical grounds, Theeuwes and Godthelp (1993, 1995) identified some criteria that will increase the self-explaining character of roads. When developing the "road of the future," one should start with a few easy recognizable and distinguishable road categories. These types of roads should be designed in such a way that high-speed differences and directional differences are not possible. Four categories can be distinguished: freeways, highways connecting larger regions, rural roads connecting residential and shopping areas, and what in Europe are called *woonerfs*—small roads going from door to door. For these four categories, self-explaining roads should fulfill the following tentative criteria:

- Roads should consist of unique road elements (homogeneous within one category and different from all other categories).
- Roads should require unique behavior for a specific category (homogeneous within one category and different from all other categories).
- Unique behavior displayed on roads should be linked to unique road elements (e.g., *woonerfs*: obstacles—slow driving, freeway: smooth concrete—fast driving).
- The layout of crossings, road sections, and curves should be linked uniquely with the particular road category (e.g., a crossing on a highway should physically and behaviorally be completely different from a crossing on a rural road).
- One should choose road categories that are behaviorally relevant.
- There should be no fast transitions going from one road category to the next.
- When there is a transition in road category, the change should be marked clearly (e.g., with rumble strips).
- When teaching the different road categories, one should not only teach the name of, but also the behavior required for, that type of road.
- Category-defining properties should be visible at night as well as in the daytime.
- The road design should reduce speed differences and differences in direction of movement.
- Road elements, marking, and signing should fulfill the standard visibility criteria.
- Traffic control systems should be uniquely linked to specific categories (e.g., on freeways, systems that regulate traffic flow; on rural roads, systems that restrict driving speed).

REFERENCES

Alexander, G. J., & Lunenfeld, H. (1986). *Driver expectancy in highway design and traffic operations* (Rep. No. FHWA-TO-86-1). Washington, DC: U.S. Department of Transportation, Federal Highway Administration.

Hughes, P. K., & Cole, B. L. (1984). Search and attention conspicuity of road traffic control devices. *Australian Road Research, 14*, 1–9.

Malaterre, G. (1986). Errors analysis and in-depth accident studies. *Ergonomics, 33*, 1403–1421.

McClelland, J., & Rumelhart, D. (1981). An interactive activation model of context effects in letter perception, Part I: An account of basic findings. *Psychological Review, 88*, 375–407.

Minsky, M. (1975). A framework for representing knowledge. In P. H. Winston (Ed.), *The psychology of computer vision*. New York: McGraw-Hill.

Räsänen, M., & Summala, H. (2000/this issue). Car drivers' adjustments to cyclists at roundabouts. *Transportation Human Factors, 2*, 1–17.

Sussman, E. D., Bishop, H., Madnick, B., & Walter, R. (1985). Driver inattention and highway safety. *Transportation Research Record, 1047*, 40–48.

Theeuwes, J. (1991). Visual selection: Exogenous and endogenous control. In A. Gale, I. D. Brown, C. M. Haslegrave, J. Moorhead, & S. Taylor (Eds.), *Vision in vehicles* (Vol. 3, pp. 53–62). Amsterdam: North-Holland.

Theeuwes, J. (1996). Visual search at intersections: An eye-movement analysis. In A. Gale, I. D. Brown, C. M. Haslegrave, & S. P. Taylor (Eds.), *Vision in vehicles* (Vol. 5, pp. 125–134). Amsterdam: North-Holland.

Theeuwes, J. (1998). Self-explaining roads: Subjective categorization of road environments. In A. Gale, I. D. Brown, C. M. Haslegrave, & S. P. Taylor (Eds.), *Vision in vehicles* (Vol. 6, pp. 279–288). Amsterdam: North-Holland.

Theeuwes, J., & Godthelp, H. (1993). Self explaining roads. In J. L. de Kroes & J. A. Stoop (Eds.), *Safety of transportation* (pp. 56–66). Delft, The Netherlands: Delft University Press.

Theeuwes, J., & Godthelp, H. (1995). Self-explaining roads. *Safety Science, 19*, 217–225.

Theeuwes, J., & Hagenzieker, M. P. (1993). Visual search of traffic scenes: On the effect of location expectations. In A. Gale, I. D. Brown, C. M. Haslegrave, & S. P. Taylor (Eds.), *Vision in vehicles* (Vol. 4, pp. 149–158). Amsterdam: North-Holland.